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PROCEEDINGS

OF THE

ROYAL SOCIETY OF EDINBURGH.

VOL. II. 1850. No. 38.

Monday, 4*th February* 1850 (*continued*).

The Hon. LORD MURRAY, V.P., in the Chair.

3. On the Ante-Columbian Discovery of America. By Dr Elton. Communicated by Dr Traill.

The object proposed by Dr Elton, is a summary of the knowledge we possess on the discovery of the Continent of America, by several adventurous European voyagers, anterior to the time of Columbus.

This subject, which has been for almost a century and a half well known to the students of northern history, was first made known to the rest of Europe by the publication of the *Vinlandia Antiqua* of the celebrated *Torfæus* in 1705; and most of the facts given by Dr Elton are extracted from that work. *Torfæus* proved from existing Icelandic MSS., that America was discovered, and even attempted to be colonized, by his enterprising countrymen, in the end of the tenth and beginning of the eleventh century; and the descriptions transmitted to us prove that they landed on what are now Newfoundland, Nova Scotia, Massachusetts, and Rhode Island.

The first adventurer was *Leif*, the son of *Eirik the Red*, who, in A.D. 995, when attempting to pay a visit to his father, the colonizer of Greenland, was driven by stress of weather to the coast of Newfoundland, which he named *Helluland*, or *Rocky Land*. From that he sailed south-westward, till he arrived at a country, which from be-

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ing covered with wood, he denominated *Markland*; and which, from the course and length of his voyage, is believed to be a part of Nova Scotia. Pursuing his course southwards, he reached a portion of Massachusetts, not far from Cape Cod; and coasting along this, he took up his winter quarters in a fertile country, which, from his description, is easily seen to have been about Rhode Island. This region, from the discovery of a species of wild vine found there, he termed *Vinland*. In the summer, he fitted out his vessel, and sailed to join his father in Greenland.

The fame of his discovery induced his brother *Thorwald*, in A.D. 1002, to sail for *Vinland*, intending to settle there; but in one of his excursions he encountered and was slain by a people, the Icelanders, in contempt denominated *Skrelings*, evidently Esquimaux, who then appear to have possessed the shores far to the south of their present location.

The next and most remarkable voyage to Vinland, was that of *Thorfinn Karlsefne*, which took place in A.D. 1006. He carried with him his wife, and one hundred and thirty-one followers, and domestic animals, with the intention of establishing a colony at the huts built by Leif in Rhode Island. The soil and climate were suitable, and they remained in that country till 1011, when they were attacked by a vast number of *Skrelings*, whom they repulsed; but the hostility of the natives induced him to abandon his design, and he finally settled in Iceland. *Thorfinn*, however, had a son, *Snorro*, born in America, from whom some of the most distinguished families in Iceland are lineally descended.

After this period, it appears that there were many voyages to *Vinland*, and that Iceland sent colonies thither for more than a century; for it is stated in Icelandic MSS., that *Eirik*, bishop of Greenland, went to *Vinland* in A.D. 1125, to confirm the colonists in the Christian faith.

The work of *Torfæus* also gives us a singular account of Icelandic voyages to a country, either a continent, or a vast island, lying far to the west of the British Islands, and near Vinland. It seems to have been first visited by *Are Marson* in A.D. 983, who was driven there by a great storm. He named it *Huitramannaland*, or *Land of White Men*, from the complexion of the natives, who were also Christians; and *Are* himself was then converted from the worship of Odin to the religion of Christ.

The same land was visited afterwards by *Gudleif Gudlagson*, an Icelandic trader with Ireland; who, in a voyage from Dublin to Iceland, was driven by a tempest to a far western land, where he was taken prisoner by the natives, but delivered by their chief, who turned out to be an *Icelander*. He was dismissed with presents, but forbidden to return. The natives were *white*, and seemed of European extraction, with a dialect like that of *Ireland;* and the American archæologists, with considerable reason, have considered that their *whereabout* was on some part of the new world, between the Chesapeake and Florida.

These early voyages seem to us very surprising; but they do not seem at all foreign to the habits and enterprise of the bold Icelanders of those ages; who not only traded to every part of the west of Europe, but to the Mediterranean, and explored *Baffin's Bay*, as high as *Lancaster Sound*. We have now a certain proof, that they were at least as high in it as at 72° 55′; for in 1825, a memorial stone with a Runic inscription, and the date of 1131, was found on the island of *Kingiktersoak*.

Several Runic inscriptions are said to have been found in America; but the most remarkable of these is the mass of *greywacke* on the shores of the river at *Dighton*, in the township of *Berkley*, in Massachusetts, not far from the supposed site of the settlement of *Thorfinn Karlsefne*. This has been lately carefully figured and engraved in the *Antiquitates Americanæ* of the Royal Soicety of Northern Antiquaries of Copenhagen, and repeated in *Jacob Aal's* translation of the *Chronicles of Snorre Sturleson*. Dr Elton, who has examined the original, assures us, that this engraving is a faithful transcript. On this rock, antiquaries read, amid figures supposed to represent Thorfinn, his wife and child, and his companions, the letters—ϙ*rfin* and *cxxxi*, the number of his companions.

Dr Elton next adverted to the voyage of the Welsh Prince, *Madoc*, son of the greatest of the princes of North Wales *Owen Gwenedd*, about the year 1170. This voyage, though doubted by many, is fully believed in by Dr Elton, and it is noticed by Hakluyt, Purchas, Broughton, &c. Dr Elton quotes the singular story given by the Rev. Morgan Jones, chaplain to the British commander of the forces of Virginia in 1669. Jones was taken prisoner by the Tusscarora Indians, who intended to torture him in their usual way, when he began to lament his cruel fate *in Welsh*, which was understood by the Indians, and he was suffered to depart in peace. These, Dr E. thinks, may have been descendants of *Madoc's followers;* and he seems inclined to ascribe to them also those very remarkable mounds, fortifications, and enclosures, which are found in such quantity in the valleys of the *Mississippi* and the *Ohio.* He is inclined also to trace to these Welsh adventurers, or at least to some early Europeans, the now almost extinct tribe, the *Mandans*—a people fairer and handsomer than the *Red men,*—that are now found 1800 miles above St Louis, on the Missouri, as described by Lewis and Clarke, and Catlin, the American travellers.

These, and several other circumstances, which might have been adduced, prove that Columbus cannot be regarded as the original discoverer of the New World.

The following Donations to the Library were announced:

Philosophical Transactions of the Royal Society of London, 1849. Part II. 4to.—*By the Society.*

Kongl. Vetenskaps. Akademiens Handlingar, för 1847 & 1848. 8vo.

Årsberättelser om Botaniske Arbeten och Uptäckter för 1843 & 1844. 8vo.

Årsberättelse om Framstegen i Kemi under År. 1847. 8vo.

Årsberättelse om Technologiens Framsteg. 1842, 1843, 1844, 1846. 8vo.

Öfversigt af Kongl. Vetenskaps. Akademiens Forhandlingar. 1848. 8vo.—*By the Academy.*

Monday, 18*th February* 1850.

The Right Rev. BISHOP TERROT, V.P., in the Chair.

The following Communications were read:—

1. On the Equilibrium of Elastic Solids. By James Clerk Maxwell, Esq. Communicated by the Secretary.

This paper commenced by pointing out the insufficiency of all theories of elastic solids, in which the equations do not contain two independent constants deduced from experiments. One of these constants is common to liquids and solids, and is called the modulus of *cubical* elasticity. The other is peculiar to solids, and is here called the modulus of *linear* elasticity. The equations of Navier, Poisson, and Lamé and Clapeyron, contain only one coefficient; and Professor G. G. Stokes of Cambridge, seems to have formed the first theory of elastic solids which recognised the independence of cubical and linear elasticity, although M. Cauchy seems to have suggested a modification of the old theories, which made the ratio of linear to cubical elasticity the same for all substances. Professor Stokes has deduced the theory of elastic solids from that of the motion of fluids, and his equations are identical with those of this paper, which are deduced from the two following assumptions.

In an element of an elastic solid, acted on by three pressures at right angles to one another, as long as the compressions do not pass the limits of perfect elasticity—

1*st*, The sum of the pressures, in three rectangular axes, is proportional to the sum of the compressions in those axes.

2*d*, The difference of the pressures in two axes at right angles to one another, is proportional to the difference of the compressions in those axes.

Or, in symbols :—

$$1.\quad \left(P_1+P_2+P_3\right)=3\,\mu\left(\frac{\delta x}{x}+\frac{\delta y}{y}+\frac{\delta z}{z}\right)$$

$$2.\quad \begin{cases} \left(P_1-P_2\right)=m\left(\dfrac{\delta x}{x}-\dfrac{\delta y}{y}\right) \\ \left(P_2-P_3\right)=m\left(\dfrac{\delta y}{y}-\dfrac{\delta z}{z}\right) \\ \left(P_3-P_1\right)=m\left(\dfrac{\delta z}{z}-\dfrac{\delta x}{x}\right) \end{cases}$$

μ being the modulus of *cubical*, and m that of *linear* elasticity.

These equations are found to be very convenient for the solution of problems, some of which were given in the latter part of the paper.

These particular cases were—

That of an elastic hollow cylinder, the exterior surface of which was fixed, while the inferior was turned through a small angle. The action of a transparent solid thus twisted on polarized light, was calculated, and the calculation confirmed by experiment.

The second case related to the torsion of cylindric rods, and a method was given by which m may be found. The quantity $E = \frac{9\,m\,n}{m + 6\,n}$ was found by elongating, or by bending the rod used to determine m, and μ is found by the equation,

$$\mu = \frac{E\,m}{9\,m - 6\,E}.$$

The effect of pressure on the surfaces of a hollow sphere or cylinder was calculated, and the result applied to the determination of the cubical compressibility of liquids and solids.

An expression was found for the curvature of an elastic plate exposed to pressure on one side; and the state of cylinders acted on by centrifugal force and by heat was determined.

The principle of the superposition of compressions and pressures was applied to the case of a bent beam, and a formula was given to determine E from the deflection of a beam supported at both ends and loaded at the middle.

The paper concluded with a conjecture, that as the quantity ω, (which expresses the relation of the inequality of pressure in a solid to the doubly-refracting force produced) is probably a function of m; the determination of these quantities for different substances might lead to a more complete theory of double refraction, and extend our knowledge of the laws of optics.

2. Two Letters from W. E. Logan, Esq., to Earl Cathcart.

These letters were dated in August 1846 and September 1847. Earl Cathcart intended himself to have read them to the Society, but, having been prevented by his official duties from coming to Edinburgh, had sent them, to be communicated in his name.

In the first letter, the author, who had been sent to examine the geology of Canada, describes a visit which he made, on his way to Fort-William, Lake Superior, to the silver and copper mines on the south side of the lake, in the territory of the United States.

He considers the formation in which the mines occur as being older than the new red. They consist of parallel ranges of trap and conglomerate, apparently interstratified. They are well displayed at and near Copper Harbour. They are sometimes so thick as to form mountain ranges. The conglomerate consists of trap pebbles in trap sandstone; the trap is sometimes compact, at other times amygdaloidal. The strata run in a curvilinear direction. They dip to the north, with a slope of 16° to 30°, the veins are at right angles to the strata, and run nearly north and south. The veinstones are steatite, quartz, calcspar, and zeolites. The ores are those of copper, silver, iron, and lead, the two former being productive. The two metals are chiefly native, but occur also in other forms. They are least abundant in the conglomerate, more so in the trap, most of all in the amygdaloid. They are found also in amygdules of the rock near the veins. The quantity of native copper is very great. In the Copper Falls Mine, near Eagle Harbour, on sinking a pit to 72 feet, the compact trap and amygdaloid were found to alternate six or seven times. The main vein was 18 to 20 inches thick. In the shaft, about 40 feet down, a mass of native copper was found, of which the dimensions were estimated by the author, *in situ*, to indicate a weight of about 30 tons. It had not yet been found possible to remove it. A diagram of its position was given.

From other shafts in the vicinity, much copper had been extracted, but with prodigious difficulty, from the tough metal binding the rock firmly together, and rendering blasting useless. The author saw, on the surface, besides many pieces of 25 lb., seven masses, varying from 75 to 1200 lb., and weighing in all 4000 lb., or nearly 2 tons. Native silver is found with the copper, and a mass of 3¼ lb. had been obtained. The author saw one of 1¼ lb. The author is of opinion that the very richness of this mine in native copper may render it unproductive, from the difficulty and expense of working it.

In the Cliff Mine, on Eagle River, there is the same abundance of copper, with more silver. Part of the rock was said to yield 7 per cent. of silver; but subsequently was found hardly to pay for its extraction. The author saw here a mass of silver of 3½ lb. Every vein in the trap seen by the author contained native copper. At the Eagle River Mine, silver is found in large masses, one of which weighed 7 lb. 2 oz.

On the Canada side, as far as the author had then examined it, from Fort-William to Pigeon River, indurated shale prevails, overlaid by greenstone, with patches of porphyry. Many trap-dikes are seen, forming long narrow promontories and deep harbours on the shore of the lake. A system of veins occurs at right angles to the dikes, containing barytes, in addition to the veinstones formerly mentioned. The veins vary from 6 inches to 20 feet. In one of them 14 or 15 feet thick, well seen on Spar Island, gray sulphuret of copper occurs in considerable abundance, especially in a part of the vein, nearly 5 feet thick. Native silver also occurs in small quantity. There are also veins parallel to the dikes which contain ores of copper. But the author could not form a decided opinion in 1846 of the value of these mines.

In the second letter, he gives some of the results of an examination of the eastern townships of Canada, from Lake Champlain and the Richelieu to the Chaudiere. He observed facts proving the green mountains of Vermont to be more recent than the Loraine shales, or Hudson River group. Of the upper rocks, the most interesting was a band of serpentine, 150 to 400 yards broad, which the author traced continuously for 150 miles, and which probably extends as far again. It has occasionally rich beds of magnetic iron and of chromate of iron; of the latter, a boulder was found, weighing 6 cwt. The gravel on the Chaudiere, besides these minerals, contains titaniferous iron and gold. The author expects to find platinum, as the gravel in all other respects resembles that of the Russian auriferous district. The auriferous sand is found on the tributaries of the Chaudiere. It will probably pay for extraction. 60 bushels washed by Mr Derby, yielded 18 dwt. 8 gr., or about 1s. 6d. worth per bushel. The gold has not yet been found *in situ*.

3. Notes on Practical Chemical subjects. By Alexander Kemp, Esq. Communicated by Professor Gregory.

1. *On the Purification of Sulphuric Acid.*

The author, after describing the different methods, recommended for purifying sulphuric acid from nitric acid, namely, boiling with a little sugar, and heating with sulphate of ammonia, both of which had proved troublesome and imperfect, stated, that after trying various plans, the only one which he found to answer well, was the action of sulphurous acid on the oil of vitriol, after diluting it to the sp. gr. of 1·715, or lower. He adds one volume of water to three of the oil of vitriol, passes sulphurous acid gas through the hot liquid till it is in excess, and then boils off the excess of sulphurous acid; or, still better, three volumes of oil of vitriol are added to or diluted with, one of a saturated solution of sulphurous acid in pure water, and boiled. The acid is thus so perfectly purified from nitric acid, that when used for making hydrochloric acid, it yields a product quite colourless, which was not the case with the oil of vitriol purified by any other process.

If the oil of vitriol be diluted with one-half its volume of sulphurous acid solution (or of water, previously to passing the gas through it), the sulphate of lead is also totally separated, and the clear liquid, decanted from the precipitate, and boiled down to sp. gr. 1·845, is colourless, and almost chemically pure.

2. *On the Preparation of Pure Hydrochloric Acid.*

Professor Gregory, in his process for preparing hydrochloric acid, by heating 1 equivalent of sea-salt with 2 equivalents of sulphuric acid of sp. gr. 1·650, directs the use of patent salt, to avoid the presence of iron in the product.

The author observed, that there is always a certain quantity of iron in the residue, even when patent salt is used; but that none passes over with the hydrochloric acid. He then added iron and peroxide of iron in considerable quantity to the materials. Still no iron passed over. It would appear, that when iron had been observed by Professor Gregory in minute quantity, in the hydrochloric acid made by his process, from common salt, it had either passed over at the very end of the process, when the temperature rose very high, although the author could not, in his own experiments, observe this, or, more probably, had been present in the test employed. It is probable that, even when much iron is present in the materials, the presence of the excess of sulphuric acid, and also the low temperature at which the process goes on, prevent the formation of the chloride of iron.

The author's observations enable us to prepare, from the commonest and cheapest salt, perfectly pure and colourless hydrochloric acid, and thus still further to reduce the price of this reagent, so essential to the chemist.

Professor Gregory also briefly stated some observations by Mr Kemp and himself, on the purification of chloroform, which he was to describe more fully at a subsequent meeting.

Dr Stark

Was balloted for, and duly and unanimously re-elected a Fellow of the Society.

Monday, 4*th March* 1850.

General Sir THOMAS MAKDOUGALL BRISBANE, Bart., President, in the Chair.

The following Communications were read :—

1. Analysis of the Anthracite of the Calton Hill, Edinburgh. By Dr A. Voelcker. Communicated by Dr George Wilson.

Dr Voelcker observed, in the introduction to his paper, that we are in possession of analyses of anthracite from different localities, from which it appears that different specimens vary much in the proportion, but very little in the nature, of their ingredients. All samples of anthracite which have been analysed, have been found to contain carbon, oxygen, hydrogen, and nitrogen, as well as more or less inorganic matter. Sulphur also has generally been found, at least when sought for ; but it does not appear in many recorded analyses.

The anthracite employed in the following analyses was furnished by Dr Fleming, and first carefully dried, after being finely powdered, by exposing it for several hours to a current of dry air, at a temperature of 230° F. The carbon and hydrogen were ascertained, by burning from three to four grains of the mineral with a mixture of oxide of copper and oxide of lead, which is much less hygroscopic than the pure oxide of copper. A mixture of this oxide and chlorate of potass was also placed in the shut end of the combustion-tube, from which oxygen was evolved in the usual way towards the close of the process.

The nitrogen was determined by Will and Varentrapp's method. The sulphur was ascertained by projecting into a red-hot platina crucible, in successive small quantities, a mixture of anthracite in powder, with nitrate of potass and carbonate of soda, and afterwards maintaining the product of deflagration at a high temperature for some time. The resulting fused mass which was perfectly white, was dissolved in water, super-saturated with hydrochloric acid, and precipitated by chloride of barium.

About ten grains of the mineral were employed in the determination of the amount of ash. It was red, and contained oxide of iron.

The following are the results of the analysis :—

Carbon,	91·23
Hydrogen,	2·91
Nitrogen,	0·59
Oxygen,	1·26
Sulphur,	2·96
Ash,	1·05
	100·00

The most remarkable peculiarity of the Calton Hill anthracite, as appears from the results given above, is the large proportion of sulphur it contains, amounting to nearly 3 per cent. Sulphur has been supposed to occur in the different varieties of coal in combination with iron, as pyrites, but the trace of that metal present in the Calton Hill anthracite is so small, that the sulphur must have been combined with the organic constituents of the mineral.

Note on the Crystallisation of Carbon, and the possible derivation of the Diamond from Anthracite and Graphite. By Dr George Wilson.

The author stated that the object of his communication was, to suggest the possibility of anthracite as well as graphite being substances from which the diamond is developed. After referring to previous theories, as all assuming that carbon must have been fluid or semifluid, before it crystallised, he stated that his hypothesis contemplated the possibility of graphite, as well as amorphous carbon, and its solid combinations, such as anthracite, undergoing crystallisation into the diamond, without losing their solidity during the change. He thought anthracite more likely than most substances to yield the diamond, for the following reasons:—

Firstly, As it occurs in nature, in many localities, it is found passing by insensible gradations, on the one hand, into common coal, on the other, into graphite; so that it may be regarded as representing the transition-state from fossilised vegetable matter to pure carbon, and as tending, under the influence of certain agencies, to change ultimately into the latter.

Secondly, The chief element of anthracite is carbon, of which it frequently contains 91, and sometimes 95 per cent.

Thirdly, Its other ingredients (with the exception of the ash, which is often under one per cent.), namely, hydrogen, oxygen, nitrogen, and sulphur, form volatile compounds with each other, and with the oxygen of the air, so that by a slow process of spontaneous decomposition, and gradual oxidation or eremacausis, all the constituents of the anthracite, except the excess of carbon and the ash, may be evolved, and carbon left free.

The separation, in this way, of the non-carbonaceous elements of the anthracite would be attended with a disturbance of the molecular equilibrium of the mineral, which would necessitate a new arrangement of its particles, and might determine the induction of the crystalline condition characteristic of the diamond. During this process, the inorganic saline matter, or ash, would either be excluded by the power crystallising bodies are known to possess of expelling heterogeneous matter, or be included in the crystallising carbon. Either view would consist with observation ; for whilst some diamonds appear to be pure carbon, many leave a slight ash when burned in oxygen.

The author further observed, that whether anthracite will crystallise into graphite or diamond, will be determined chiefly by the temperature at which crystallisation occurs, and the rapidity with which it proceeds. Graphite represents the condition of most stable equilibrium, which the crystalline molecules of carbon assume, when aggregated rapidly at a high temperature. The diamond, on the other hand, has all the characters of a crystal which has formed very slowly at a lower temperature, and it will not change into graphite, unless it be suddenly exposed to an intense heat. Whenever, therefore, carbon crystallises very slowly at ordinary temperatures, it may be expected to become the diamond rather than graphite, and the latter must be considered as a substance which, when not maintained at an elevated temperature, is liable to re-arrange its particles in the condition of more stable equilibrium characteristic of the diamond. The author, at the same time, observed, that he did not seek to affirm that all diamonds had been produced from anthracite or graphite, but thought it, on the other hand, probable, that, like other crystallisable substances, carbon might be crystallised in various ways.

2. On the Proportion of Fluoride of Calcium present in the Baltic. By Professor Forchammer of Copenhagen. With some preliminary Remarks on the presence of Fluorine in different ocean waters. By Dr George Wilson.

Dr Wilson reminded the Society that he had announced to them in 1846 the occurrence of fluorine in the water of the Frith of

Forth, and mentioned, that, in the preceding summer, he had found it in deposits obtained during the evaporation of sea-water from the Frith of Clyde, and the German Ocean. Professor Forchammer had made similar observations on the Baltic, and had furnished Dr Wilson with the account of them which follows. Before reading this, he wished to add, that he had recently examined incrustations from the boiler of a steam-vessel sailing between Liverpool and Dublin, and similar deposits from the Canada Transatlantic steamer, and H.M. war-steamer Sidon, which had been three years on the Mediterranean station. The different crusts were, without preliminary treatment, except reduction to powder, heated with oil of vitriol, and were found to yield an acid vapour which etched glass. Specimens of glass, in illustration, were shewn to the Society. From these observations, Dr Wilson inferred the presence of fluorine in the Friths of Forth and Clyde, in the German Ocean, the Irish Sea, the Atlantic, and the Mediterranean. He then proceeded to read Professor Forchammer's communication, which follows. It is dated, Copenhagen, 20th December 1849.

Abstract of a Paper by Professor Forchammer, on the rarer Substances which occur in Sea-water.

Fluorine and Phosphoric Acid.

100 lb. of sea-water, as it occurs in the Sound, near Copenhagen, of which the average quantity of salts is between 2 and 2½ per cent., was evaporated. When the solution was so concentrated that it began to deposit salt, it was, without filtering it, mixed with an excess of ammonia, and the precipitate collected and washed. The whole precipitate which contains carbonate, sulphate, and phosphate of lime, fluoride of calcium, silica, and magnesia, was redissolved in muriatic acid, which left the greater part of silica undissolved; the solution was mixed with muriate of ammonia, and a second time precipitated by an excess of ammonia. This precipitate from 100 lb. of sea-water weighed 3·104 grains, and consisted of phosphate of lime and fluoride of calcium. It was divided into two equal parts, of which the one was in a platina crucible, mixed with concentrated sulphuric acid, and allowed to act on a slip of glass, covered with wax, in which some words were scratched with a copper needle. The glass was most decidedly etched, but the words appeared more clear

and legible if breathed upon. The second half part was likewise mixed with sulphuric acid, but in a bent tube, and distilled into a small vessel which contained a weak solution of ammonia. The tube was etched, and the vessel contained precipitated silica. It was thus completely proved that sea-water contains fluoride of calcium, but the quantity in 100 lb. sea-water from the Sound at Copenhagen can hardly exceed one-half of a grain, or since the proportion of the different salts varies very little in sea-water, it will be about one grain in 100 lb. of water of the ocean, which contains between 3·5 and 4 per cent. of salts.

All the residuums from the trials to find fluorine were dissolved in muriatic acid, and thrown down by an excess of ammonia. The precipitate, washed, dried, and heated, was mixed with potassium in a glass tube [and heated], until the excess of potassium was driven off. The lower part of the tube was cut off and thrown into water, where it for hours continued to give out small bubbles, distinguished by the peculiar smell of phosphuretted hydrogen, although they did not inflame by themselves. Thus the existence of phosphoric acid was likewise proved, although I could not try the delicate test for phosphoric acid which we owe to Mr Svanberg, it not being known at the time when I made my experiments.

In all the different species of corals which I analysed, I likewise found fluorine.

In a postscript to the preceding communication, Professor Forchammer states, that the paper, of which it is an abstract, " contains experiments on many other substances, contained in minute quantities, in sea-water; for instance, manganese, ammonia, baryta, or strontia, besides iron and silica, which occur in proportionally large quantities."—G. W.

3. On an Application of the Laws of Numerical Harmonic Ratio to Forms generally, and particularly to that of the Human Figure. By D. R. Hay, Esq.

The author stated in some prefatory remarks, that a belief in the operation of the laws of numerical harmonic ratio in the constitution of beautiful forms had long existed, although those laws had not been systematised so as to render them applicable in the formative arts. In proof of this, Mr Hay quoted a correspondence upon the subject of harmonic ratio, between Sir John Harrington and Sir Isaac Newton, in which the latter expresses his belief in such laws in the following words: "I am inclined to believe some general laws of the Creator prevailed with respect to the agreeable or unpleasing affections of all our senses; at least the supposition does not derogate from the power or wisdom of God, and seems highly consonant to the simplicity of the macrocosm in general." The belief of this great philosopher, the author trusted, would form some apology to men of science for the repeated attempts he has made to establish the fact. These attempts he had hitherto made with reference to architecture, to ornamental design, and latterly to the human head and countenance; but on the present occasion he intended to shew the operation of these laws in constituting the symmetrical beauty of the entire human figure.

He next proceeded to point out the remarkable similarity that exists in the physical constitution of the organs of hearing and seeing, and the manner in which external nature affects the sensorium through these organs; shewing the difference between noises and musical sounds in the one case, and irregular and regular forms in the other. He explained that each musical sound was produced by a number of equal and regular impulses made upon the air, the frequency of which determining the pitch of the sound, their violence its loudness; and the nature of the material by which the impulses were made its quality or tone. In like manner, he shewed that the effect upon the optic nerve produced by external objects is simply that of the action of light, and amenable to the same laws. Variety of form being analogous to variety of pitch; variety of size to that of intensity or loudness, and variety of colour to that of quality or tone.

Mr Hay next explained the nature of the harmonics of sound, which result from the spontaneous division of the string of a monochord by the formation of nodes during its vibratory motion. He then shewed how the harmonics of form could be evolved from the quadrant of a circle by the following process:—

From a horizontal line MR (figure 1, of the annexed Plate), he produced two parallel vertical lines ML and RS indefinitely, and with a radius MR described, from the centre M, the quadrant OR. From O he divided the arc of the quadrant into parts of $\frac{1}{8}$, $\frac{1}{7}$, $\frac{1}{6}$, $\frac{1}{5}$, $\frac{1}{4}$, $\frac{1}{3}$, and $\frac{1}{2}$. From the centre M, and through these divisions, he produced the lines MN, MP, MQ, MT, MU, MV, and MS, until they met RS, forming the right-angled triangles MPR, MQR, MTR, MUR, MVR, and MSR. He then shewed, that as the angles at the vertex of each of these triangles, contained respectively 45°, 30°, 22° 30′, 18°, 15°, 12° 51′ 26″, 11° 15′, they related to the right angle, as the harmonics of sound, expressed by the signs c, g, c̄, ē, ḡ, b̄♭, and c̿, relate to the fundamental note C, produced by the string of the monochord. These triangles he combined in the following manner upon a line AB (figure 2, of the annexed Plate), which he said might be of any given length according to the size of the figure to be formed. From B at an angle of 11° 15′ with AB he drew the line Bg indefinitely, and from A at an angle of 15° with AB the line Ar, also indefinitely, and cutting Bg in K. Through K he drew KL at right angles with AB, forming the triangles ALK and KLB. Through K he drew the line pO parallel to AB. From A at an angle of 12° 51′ 26″ with AB he drew AV, cutting pO in M, and drew MN at right angles with AB, forming the triangle AMN. From A at an angle of 18° with AB, he drew Au, cutting pO in H, and drew HI at right angles with AB, forming the triangle AHI. From A at an angle of 22° 30′ with AB, he drew At, cutting pO in F, and drew FG at right angles with AB, forming the triangle AFG. From A at an angle of 30° with AB he drew As, cutting pO in C, and drew CD at right angles with AB, forming the triangle ACD. From C at an angle of 45° with AB and CD he drew CE, forming the triangle CDE. Thus, he observed, were the triangles arising from the harmonic angles constructed upon AB in the same relative proportions to each other, that they were when formed upon the line RS, figure 1. Upon the other side of AB he constructed similar triangles forming the equilateral triangle ACC; the right-angled isosceles triangle ECC, and the acute-angled isosceles triangles AFF, AHH, AKK, AMM, and BKK. Within this diagram he shewed that the human skeleton could be formed in the most perfect proportions, determining, at the same time, the centres of all the various motions of the joints; and also that the symmetrical beauty of the external form, whether in a front or profile view, was governed by these angles; thus endeavouring to prove that an application of the laws of numerical harmonic ratio in the practice of the sculptor and painter would give these imitative arts a more scientific character than they at present possess, and, so far from retarding the efforts of genius, would rather tend to facilitate and assist them.

FIGURE I.

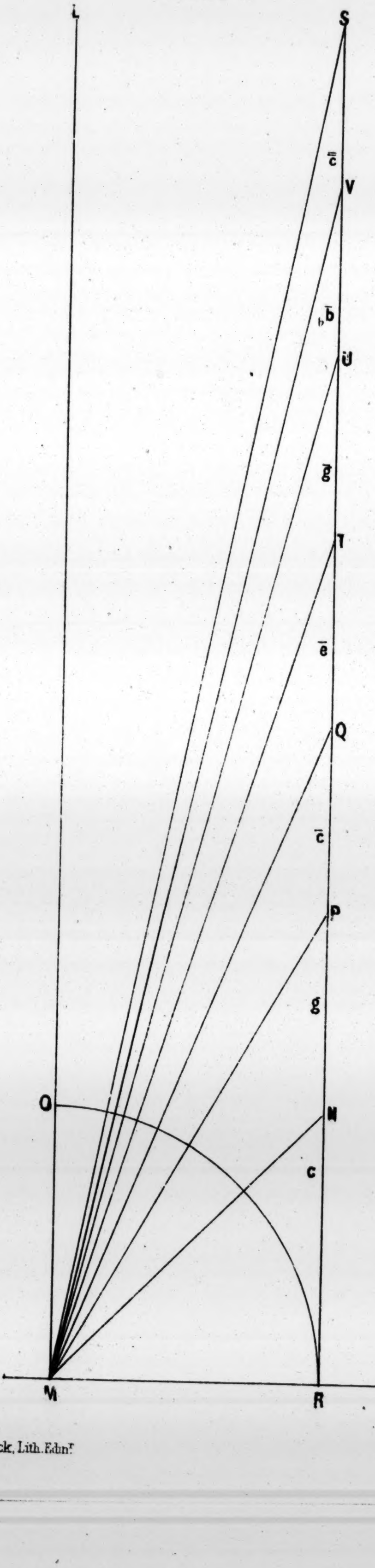
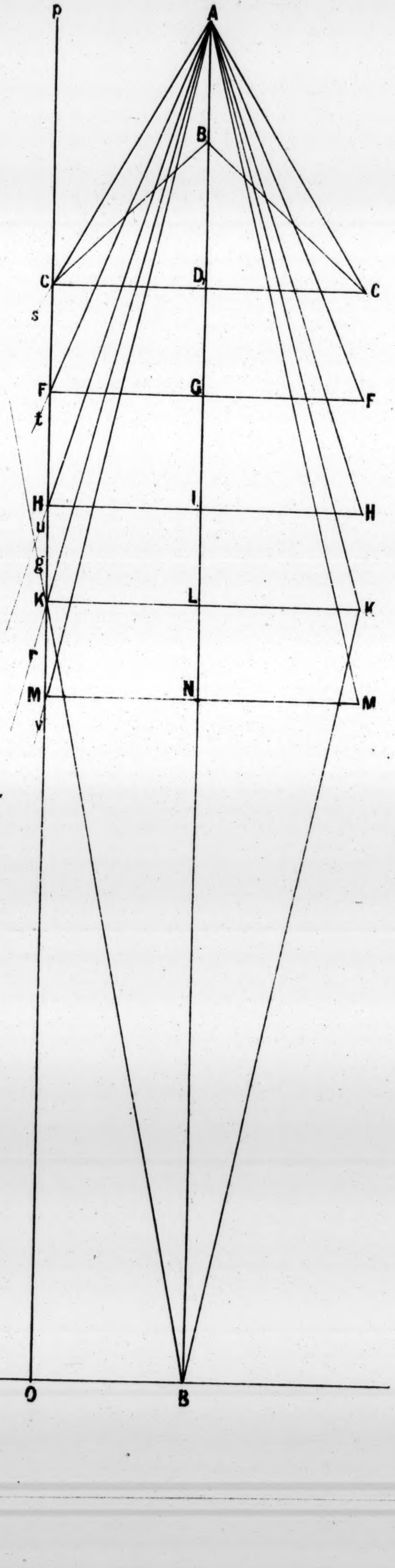


FIGURE 2.



Fr Schenck, Lith. Edinr